DOCUMENT RESUME

ED 164 262 SE 025 279

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TITLE Expectancies, Utility Values, and Attributions for Performance in Mathematics.
PUB DATE Mar 78
NOTE 13p.; Paper presented at the annual meeting of the American Educational Research Association (Toronto, Canada, March 27-31, 1978); Contains occasional marginal legibility

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Academic Ability; *Attitudes; *Educational Research; Elementary Secondary Education; Research; *Role Perception; *Secondary School Mathematics; *Sex Differences
IDENTIFIERS *Research Reports

ABSTRACT

Some of the determinants of the decision to take or not to take mathematics are explored. The focus is on sex and grade differences in responses to questions about mathematics. The results show that fifth- and sixth-grade girls tended to have higher expectancies for success as well as higher ratings of their ability in mathematics than the boys reported. Ninth-grade girls also had higher expectancies for success than did boys, but lower ratings of their ability in mathematics. (MP)

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ED164262

Expectancies, Utility Values, and Attributions for Performance in Mathematics

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Paper Presented at a Meeting of the American Educational Research Association, March, 1978, Toronto, Canada.

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Expectancies, Utility Values, and Attributions for Performance in Mathematics

Researchers studying sex differences in mathematics achievement have consistently reported superior performance by boys than by girls (Aiken, 1976; Maccoby & Jacklin, 1974). However, many of the relevant studies have failed to control for the number of mathematics courses taken. Thus, males who have taken more mathematics courses are often compared with females who have taken fewer courses. It has been suggested by Fennema and Sherman and others (Fennema, 1976; Fennema & Sherman, 1977; Fox, 1976) that differential course taking by males and females accounts for a large portion of the sex differences found on test scores. When the number of years studying math is equated for males and females, the differences typically found on high school achievement tests between the sexes are few.

The purpose of this present research project is to explore some of the determinants of the decision to take or not to take mathematics. In most schools, students have the choice of whether or not to continue in math after one year of high school math. Some of the causes which influence this decision might be impossible to change, such as parents' education or their present careers. However, some factors influencing students' decisions to take math may be modifiable. Having identified these factors, one could intervene and increase the likelihood of students continuing to take mathematics so that later remediation would be less necessary.

The variables selected for study are derived from an expectancy/value model of behavior. This psychological model based, in turn, on decision, achievement, and attribution theory (e.g., Atkinson, 1964; Edwards, 1954; Weiner, 1972) links behavioral choice, in this case the decision to take mathematics, to both one's expectancy for success in the task and the incentive value of the task for the individual. The model also suggests a number of variables that might mediate

both one's expectancies for success and the incentive value of the task. These mediating factors are shown on Table 1.

Insert Table 1 about here

The study to be described is part of an extensive project designed to test this model. Questions that assessed the expectancies for mathematics, the incentive value of mathematics, and the proposed mediators were given to students in fifth, sixth, and ninth grades. The junior high school years are critical in the development of attitudes toward math and past research has shown that the relation between attitudes toward mathematics and math achievement increases with grade (Fennema, 1976). The attitudes of the ninth grade students will be compared to those of the children in the fifth and sixth grade, where typically, sex differences in math achievement and attitudes are not found (Fennema, 1976). Thus, sex and grade differences in responses to questions about mathematics were the focus of the present study.

Method

Subjects

The subjects in this study were drawn from an elementary school and a junior high school in a suburban community near Detroit. There were 41 elementary school children (23 boys, 18 girls) from two combined fifth/sixth grade classes and 59 junior high school students from two ninth grade math classes (34 boys, 25 girls).

Measures

The questionnaire used in this study assessed students' expectancies for success in math, the perceived incentive value of math, and those variables hypothesized to mediate each. The response format for most questions was a 9-point bipolar scale. The questionnaire was composed of the following subscales:

Expectancies for success. Students rated how well they expected to perform in both their current and future math courses as well as in a career which required mathematical aptitude. The variables proposed to mediate expectancies for success are listed below:

(1) Perceived ability. Students rated how good they believed they were in math; how good they were relative to their peers; how good they were in math relative to their ability in other academic courses; and how good in math they believed their parents and math teacher felt they were.

(2) Perceived task difficulty. Students were asked how difficult they found their current math course both in absolute terms and relative to their other academic courses; how difficult they believed an advanced math course would be for them; and how difficult they thought their parents and teachers felt math was for students.

(3) Causal attributions for success and failure. Students' causal attributions for performance in math were assessed by asking them to rate a number of potential reasons (e.g., ability, task difficulty, help from others, etc.) for their performance in three situations: (1) their overall level of performance in their current math course; (2) success (a very high grade) on a math test; and (3) failure (a very low grade) on a math test.

(4) Perceptions of the expectancies of significant others. Students rated how well they believed both their parents and math teacher expected them to do in their current math course, a more advanced math course, and a career which required mathematical aptitude.

Incentive value. Within our model incentive value has two components: utility value or the perceived instrumentality of math for future goals, and attainment value or the importance of doing well in math. Students rated how useful they believed math

would be for what they planned to do upon completing school. With regard to attainment value, students were asked how important it was to them to do well in math both in absolute terms, and in comparison with their other academic subjects. Students were also asked how important it was to their parents that they (the students) did well in math. The variables proposed to mediate value are listed below:

(1) Sex-role values. Students' stereotyping of math as a sex-typed achievement domain was measured by asking them to compare the sexes in terms of mathematical aptitude, level of performance in advanced math courses, the perceived task difficulty of math, and the utility of basic math for men's and women's jobs and everyday activities.

(2) Cost of success. Students rated how hard they had to work in order to do well in math.

Supplementary questions. Students were asked some additional questions specifically about math (e.g., how much they like math, how well they were doing in math this year), as well as some questions concerning their level of performance in and attitudes toward other school courses, and their future educational plans.

Due to the length of the questionnaire, all students answered questions concerning expectancies for success, utility value, and causal attributions for general performance in math plus a subset of the remaining subscales. Thus, approximately equal numbers of students at each grade level answered questions concerning attainment value, perceived ability, perceived task difficulty, causal attribution for success and failure, sex-role values, and the cost of success.

Results and Discussion

Answers to the questionnaire were analyzed in a 2 (sex) x 2 (grade) analysis of variance.

Expectancies for success. Significant group differences were found on

several of the questions which assessed expectancies for success in math. Girls stated that they expected to get higher grades on their next math test than did boys, $F(1, 87) = 3.89$, $p < .05$. With regard to expectancies for success in an advanced math course, an age X sex interaction, $F(1, 86) = 4.39$, $p < .05$, reflected the fact that the younger girls tended to give higher expectancy statements than did all other groups. Girls did not report higher expectancies for success for their next report card grade in math, performance in math next year, or a career which required mathematical aptitude.

(1) Perceived ability. With regard to students' perceived ability in math, a fairly consistent pattern of results emerged. In the fifth and sixth grades, girls tended to rate themselves as more able in math than did boys; however, by the ninth grade, boys perceived themselves as more able in math than did the girls. This age X sex interaction was found for questions concerning perceived ability in math, $F(1, 31) = 4.03$, $p < .05$, perceived ability in comparison with peers, $F(1, 31) = 5.20$, $p < .05$, and performance when called upon by the teacher during a math class, $F(1, 30) = 4.0$, $p < .05$.

Consistent with students' self-perceptions of ability, there was a tendency for younger girls to believe that their mothers and teachers felt they were better in math than in other subjects more than the younger boys did, while ninth grade boys tended to state that their mothers and teachers felt they (the boys) were better in math than in other subjects more than the older girls did, $F(1, 29) = 3.82$, $p < .06$ and $F(1, 26) = 3.83$, $p < .06$ respectively.

(2) Perceived task difficulty. In general, significant group differences were not found for students' perceptions of the difficulty of current and future math courses.

(3) Causal attributions for success and failure. With regard to causal attributions for students' overall level of performance in math this year, girls tended to rate effort, $F(1, 89) = 3.19$, $p < .07$, and paying attention in class,

$F(1,89) = 3.41$, $p < .06$, as more important than did boys, while boys placed a greater emphasis on the amount of help they received from the teacher $F(1,88) = 7.39$, $p < .01$. Older students rated the amount of help from the teacher $F(1,88) = 3.99$, $p < .05$, and how well the teacher explains math, $F(1,86) = 3.29$, $p < .07$, as more important in accounting for their overall level of performance in math than did younger students. They placed less emphasis on both the importance of help from parents, $F(1,87) = 7.67$, $p < .01$, and the subjective importance of doing well in school subjects in general, $F(1,88) = 6.31$, $p < .01$, than did younger students.

While significant group differences did not occur for causal attributions for success on a math test, a number of age differences were observed for attributions for failure. Older students placed greater emphasis on the importance of studying for the exam, $F(1, 31) = 4.89$, $p < .05$, persistent effort in the course, $F(1, 32) = 3.71$, $p < .06$, and carelessness when taking the test, $F(1, 32) = 9.12$, $p < .01$, than did younger students, and attributed less importance to guessing the wrong answers (bad luck), $F(1, 34) = 7.30$, $p < .01$. The only sex difference in attributions for failure was that girls tended to place greater emphasis on guessing the wrong answer than did boys, $F(1, 34) = 3.95$, $p < .06$.

(4) Perceptions of the expectancies of significant others. In general, significant group differences were not observed in students' perceptions of the expectations of their parents and teachers for their (students') performance in math. Girls did state that they perceived that their teachers expected that they would receive somewhat higher math grades than did boys, $F(1, 84) = 5.26$, $p < .05$.

Incentive Value. With regard to the perceived utility of math, younger girls rated basic math as more important to their future aspirations than did younger boys. and also saw basic math as more useful for other school subjects than did younger boys; among older students, these findings were reversed, $F(1, 88) = 10.20$, $p < .01$, $F(1, 87) = 4.35$, $p < .05$ respectively. In terms of attainment value, group differences were not observed in how important students believed it was to do well in math,

nor in how important they believed significant others felt it was for them to do well in math.

(1) Sex-role values. Group differences were generally not found in the way or extent to which students perceived math to be a sex-typed achievement domain. All students tended to think that men would find basic math more useful for their jobs than would women, but that men and women would find basic math equally useful with regard to their everyday activities. Students rated boys and girls as equal in their math aptitude and their ability to use basic math.

(2) Cost of success. Significant group differences were not found in the amount of effort students felt was required to do well in math.

Summary

Despite higher expectations by girls for their next math test grade, ninth grade girls perceived themselves as having less ability in math than the boys did. This was not true for the fifth and sixth grade girls, who tended to have both higher expectancies for success as well as higher ratings of their ability in math than the boys did. Girls also reported that they were doing better in math this year than the boys reported, $F(1, 94) = 4.52$, $p<.05$. Ninth grade girls' expectancies for success were not adversely affected by their lower perceptions of ability; but were more influenced by current performance.

In contrast to this generally optimistic evaluation of the girls' current performance in math were the ratings of school performance in general. A grade x sex interaction revealed that while younger girls said they were doing better in school than the boys did, older boys thought they were doing better in school in general than did girls, $F(1, 94) = 11.33$, $p<.001$. This may reflect more modesty by the ninth grade girls or changing standards for scholastic self-evaluation.

Future research from this project will focus on the relation between the hypothesized mediators and expectancies and incentive values. Students in the intervening grades will also be tested to see when perceived ability ratings in

girls begin to drop. Finally, the mathematics-relevant attitudes of parents and mathematics teachers will be assessed and their relation to students' attitudes will be determined .

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